

Parental Smoking and Respiratory Illness During Early Childhood: A Six-year Longitudinal Study

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Summary. The relationship between parental smoking habits and lower respiratory illness and symptoms during the first 6 years of life was studied in a birth cohort of New Zealand children. This showed that maternal (but not paternal) smoking was associated with significant increase in rates of lower respiratory infection and lower respiratory symptoms during the child's first 2 years. This association persisted when a range of perinatal, social and familial factors were taken into account statistically. After two years there was no detectable association between parental smoking habits and lower respiratory infection. Further, there was no evidence to suggest that children whose parents smoked had increased risks of asthma or rates of asthmatic attacks during early childhood. (Key words: asthma; children; cigarette smoking; lower respiratory illness; parental smoking.) *Pediatr Pulmonol* 1985; 1:99-106

A number of studies have examined the relationship between parental smoking and lower respiratory illness in children¹⁻¹² and, in general, the results have suggested that parental smoking may be harmful to children. Perhaps the best-documented findings relate to the increased rates of lower respiratory infection and symptoms that have been observed in children under 2 years of age whose parents (and, particularly, the mothers) smoke.^{1,3,13-15} This association has been found in a variety of studies that have used both retrospective and concurrent measures of medical consultation for lower respiratory infection,^{1,3,16-18} maternal reports of lower respiratory symptoms,¹⁹ and hospital attendance data.² The correlation has been shown to persist when a large number of potentially confounding factors have been controlled, including family social background,^{1,3,16,18} family composition,²⁰ lower respiratory illness in the child's family,^{1,21} infant feeding practices,²² and perinatal history.^{1,23} In at least two studies the association in children between early lower respiratory illness and parental smoking has been shown to disappear at around 2 years of age.^{1,2}

A further series of studies have suggested that, in school-aged children, parental smoking and, particularly, maternal smoking is associated with increased rates of lower respiratory

symptoms,²⁴⁻²⁶ lower respiratory infection,²⁷⁻²⁹ and reduced pulmonary function.³⁰⁻³² The introduction of control factors, including measures of family social background³³⁻³⁵ and the children's smoking habits,³⁶⁻³⁸ has not appreciably altered these correlations. At the same time, not all studies of school-aged populations have found linkages between parental smoking and pulmonary function.³⁹⁻⁴¹

A number of investigators have also examined the relationship between parental smoking and the onset and frequency of asthma during childhood, and the majority of studies⁴²⁻⁴⁷ have failed to find any tendency for the children of parents who smoke to be more prone to asthma than those of nonsmokers. An exception to this trend, however, was reported by Gortmaker et al.,⁴⁸ who found a small but statistically significant tendency for children whose parents smoked to suffer greater rates of asthma.

Although the general conclusion that may be drawn from this literature is that smoking is harmful for children, some aspects of the findings suggest that this relationship may not be a simple one. In particular, the emerging evidence tends to suggest that the effects of parental smoking vary with the age of the child (being most marked during early childhood), the source of the parental smoke (with maternal smoking having a greater influence than paternal smoking), and the disease that is studied (with lower respiratory infection and symptoms being more influenced by parental smoking habits than childhood asthma).

To place these issues in perspective, this pa-

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Received October 11, 1984; accepted for publication November 19, 1984.

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per reports the results of a six-year longitudinal study of the relationship between parental smoking habits and lower respiratory illness in children in a sample of New Zealand children. The aims of the paper are: 1) To examine the relationship between rates of lower respiratory infection or symptoms in children, parental smoking habits, and the children's ages and to devise a statistical model describing the linkages between these variables. 2) To examine the association between parental smoking and the onset of asthma and the frequency of asthmatic attacks during early childhood.

Method

The data were collected during the first eight stages of the Christchurch Child Development Study. A birth cohort of children born in the Christchurch (New Zealand) urban region in mid-1977 was studied at birth, 4 months, and annual intervals to the age of 6 years using a combination of a home-based interview with the mother supplemented by information from hospital records, general practitioner notes, and other documentary sources. The general methods of data collection and the quality control of the data have been described in previous papers.¹⁻³ The following information was used in the present analysis.

Medical Consultation for Lower Respiratory Infection. Information on medical consultations for bronchitis, bronchiolitis, and pneumonia was collected for each child for each year of life. This information was gathered from several sources including maternal recall, diaries of the children's health that were kept each year by the mothers, and information from general practitioner records.

Maternal Reports of Lower Respiratory Symptoms. Mothers were questioned about whether their child had had a "chesty cold" or "wheezy chest" at each year of life irrespective of whether a medical consultation had been involved. Separate items for chesty cold and wheeze were used for children up to 2 years of age. However, during the first year of the study, our interviewers reported that many mothers had difficulty distinguishing between wheeze and general chestiness. To overcome this possible ambiguity, from the second year onward we used a single item that covered both chesty cold and wheeze. The measure used in this analysis is based on whether at each year of life, the mother reported that her child had suffered from

chesty colds or wheeze irrespective of whether medical attention was sought for these conditions.

Asthma During Early Childhood. To measure whether a child was prone to asthma and, if so, the frequency of the asthmatic attacks, four measures were developed:

1.—whether the child had ever attended a medical practitioner for the treatment of wheeze that had been diagnosed as asthma or wheezy bronchitis. (Wheezy bronchitis was included in the definition of asthma on the basis of Williams and McNicol's⁴ conclusion that the two conditions are indistinguishable; however, only 8% of all diagnoses were for wheezy bronchitis.)

2.—whether the mother had ever reported that her child had suffered an asthmatic attack irrespective of whether this attack had been treated medically.

3.—the frequency of medical attendance from birth to 6 years for episodes of wheeze that were diagnosed as asthma or wheezy bronchitis.

4.—the frequency of maternal reports of asthmatic episodes during the period from birth to 6 years irrespective of whether medical attendance was sought.

The first two measures defined the proportion of children who, according to medical diagnosis or maternal belief, were prone to asthma; the second two measures described the frequency of asthmatic attack among those children who were susceptible to asthma.

Parental Smoking. At each year, mothers were questioned about their daily cigarette intake and the intake of the child's father.

Control Factors

To take account of the possibility that any apparent correlations between parental smoking and lower respiratory illness could have arisen from the effects of common confounding variables, the following measures were used for the purpose of statistical control.

Perinatal Status. Measures of the children's birthweights and estimated gestational ages were obtained from hospital records.

Family Composition and Social Background. As part of the routine data collected during the course of the study, information was available on maternal ages, family sizes, maternal educational levels, the children's ethnicity, and family socioeconomic statuses as measured by the Elley and Irving⁵ scale of socioeconomic status for New Zealand.

Family Atopy. At the initial interviews with

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Table 1—Rates per 100 Children of Medical Consultations for Bronchitis/Pneumonia and Maternal Reports of Lower Respiratory Symptoms by Age of Child and Parental Smoking Habits (Number of Children in Sample in Parentheses)

	Medical Consultation for Bronchitis/Pneumonia				Maternal Reports of Lower Respiratory Symptoms			
	0	1-10	11+	Total	0	1-10	11+	Total
Children 0-2 years								
Paternal smoking (cigs/day)								
0	14.6 (575)	22.7 (75)	25.2 (115)	17.0 (765)	60.9 (575)	66.7 (75)	70.4 (115)	62.9 (765)
1-10	9.1 (66)	14.0 (43)	23.5 (17)	12.7 (126)	54.6 (66)	74.4 (43)	70.6 (17)	63.5 (126)
11+	8.3 (120)	25.0 (52)	28.4 (81)	22.9 (253)	67.5 (120)	63.5 (52)	71.6 (81)	70.2 (253)
Total	14.7 (761)	21.2 (170)	26.3 (213)	17.8 (1144)	61.4 (761)	67.7 (170)	70.9 (213)	64.1 (1144)
Children 2-4 years								
Paternal smoking (cigs/day)								
0	13.7 (590)	9.9 (71)	17.0 (112)	13.8 (773)	53.2 (590)	59.9 (71)	58.9 (112)	54.6 (773)
1-10	16.0 (75)	8.7 (23)	20.8 (24)	15.6 (122)	60.0 (75)	34.8 (23)	58.3 (24)	54.0 (122)
11+	15.2 (105)	13.9 (36)	15.6 (64)	15.1 (205)	59.4 (105)	59.8 (36)	62.5 (64)	55.6 (205)
Total	14.2 (770)	10.8 (130)	17.0 (200)	14.3 (1100)	53.8 (770)	53.1 (130)	60.0 (200)	54.8 (1100)
Children 4-6 years								
Paternal smoking (cigs/day)								
0	11.1 (586)	17.5 (59)	10.7 (121)	11.5 (766)	51.5 (586)	55.9 (59)	53.7 (121)	52.9 (766)
1-10	6.1 (66)	17.4 (22)	13.0 (23)	9.8 (112)	51.5 (66)	60.9 (22)	70.0 (23)	57.1 (112)
11+	12.3 (106)	12.5 (41)	7.8 (77)	10.8 (223)	52.8 (106)	52.5 (40)	54.6 (77)	53.4 (223)
Total	10.8 (758)	15.4 (122)	10.0 (221)	11.2 (1101)	51.7 (758)	55.7 (122)	55.7 (221)	53.0 (1101)

the children's mothers. Information was collected on the presence (both past and present) of asthma, allergic rhinitis, and eczema in the mother, biological father, and siblings.

Breastfeeding History. From information collected from hospital notes and maternal interviews, estimates of the duration of time (if at all) the child was breastfed were obtained.

Pets in the Home. At each year, mothers were questioned about the presence of pet cats or dogs in the children's families, and an estimate of the extent of exposure to these animals was created for each child by summing the number of years the pets had been in the child's family.

Family Life Events. From two years onward, mothers were questioned about the occurrence of adverse or stressful life events using a 26-item check list based on an abbreviated version of the Holmes and Rahe¹¹ social readjustment rating scale. For each year, an estimate of the extent of exposure to stressful life events was created by summing the number of such events reported.

Sample Sizes

The initial cohort comprised 1,265 children, but as a result of emigration from New Zealand and losses to follow up, this cohort was reduced in 6 years to 1,115 children. This reduced sample represented 88% of the original cohort and 95% of those cohort members still alive and resident in New Zealand. However, throughout the analysis, sample sizes varied with the age of the children because complete data on parental smoking and respiratory illness for the full six-year period were not available for every child. (These were children who had left New Zealand, and who re-entered the study on their return.) The variations in sample size are reflected in tables 1, 4, and 5.

Results

Medical Consultation for Lower Respiratory Infection and Maternal Reports of Lower Respiratory Symptoms. Table 1 shows the associations between parental smoking habits and rates

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Table 2—Risks per 100 Children Aged 0-2 years of Bronchitis/Pneumonia and Lower Respiratory Symptoms by Maternal Smoking Adjusted for Family Size, Perinatal Status, Breastfeeding, and Family Social Circumstances

Maternal Daily Cigarette Intake	Bronchitis/Pneumonia	Lower Respiratory Symptoms
Nonsmoker	15.3	61.6
1-10 per day	19.5	65.0
11+ per day	24.5	68.2

of medical consultation for bronchitis and pneumonia and maternal reports of lower respiratory symptoms in their child during the period from birth to 6 years. (The data are presented in two-year blocks for simplicity, but a parallel analysis of the year-by-year trends in the data produced similar results.) Inspection of the table suggests that parental smoking and, particularly, maternal smoking was associated with increased rates of medical consultation and increased maternal reports of lower respiratory symptoms in the children we studied during the first two years of life. However, after the children reached 2 years of age, there appeared to be little or no association between parental smoking habits and the rates of lower respiratory illness or symptoms. These conclusions were confirmed by fitting a series of hierarchical log linear models²² to the data on rates of lower respiratory illness shown in the table. This procedure led to the following conclusions. 1) During the children's first 2 years of life, maternal smoking was associated with significant increases in rates of medical consultation for lower respiratory infection (log likelihood ratio $\chi^2 = 15.90$, df = 2, $P < 0.001$) and maternal reports of lower respiratory symptoms (log likelihood ratio $\chi^2 = 8.27$, df = 2, $P < 0.05$). Paternal smoking did not make a contribution to the variability in rates of illness when considered alone or in combination with maternal smoking. 2) After the children reached 2 years of age, there were no significant associations between parental smoking habits and rates of lower respiratory illness or symptoms.

The results in table 1 do not take into account the possible effects of other social or familiar factors that may be correlated with maternal smoking habits and childhood lower respiratory illness or symptoms. To examine this issue, the data for the first 2 years were reanalyzed using logistic regression methods²³ in which maternal smoking together with the measures of family social background, family composition, infant feeding practices, and perinatal history were related to rates of medical consultation for bronchitis and pneumonia and rates of maternal

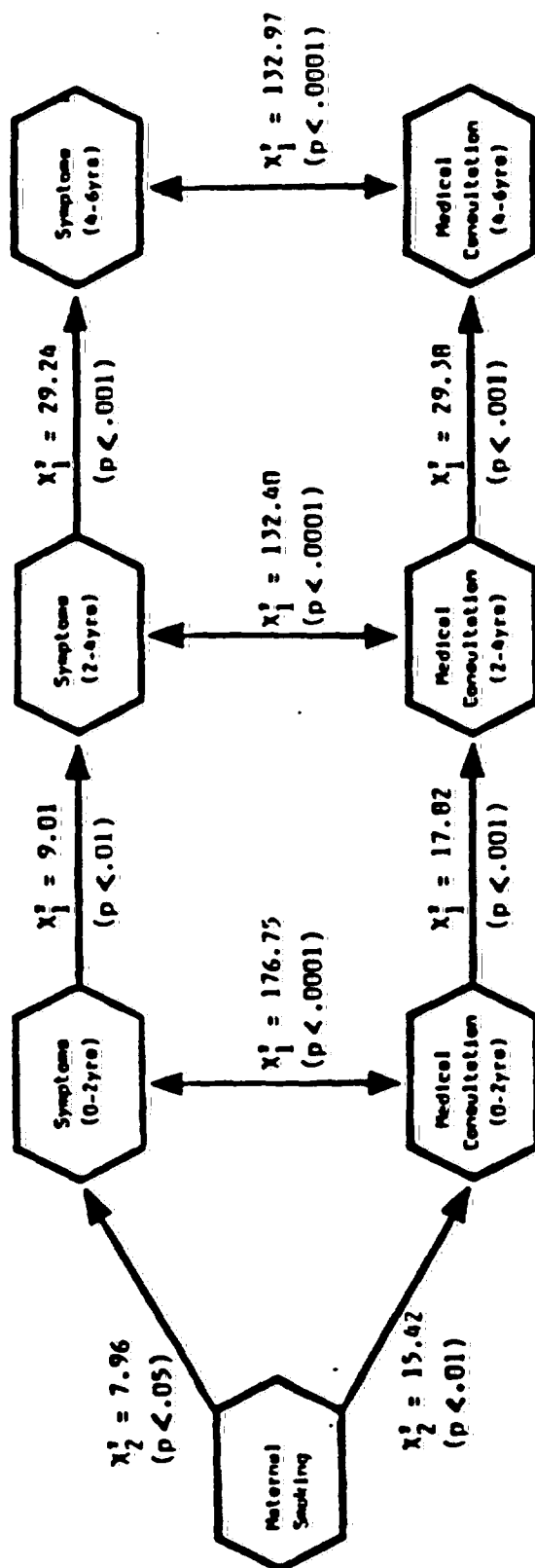
reports of symptoms. Results of this analysis clearly showed that, even when all control factors were taken into account, there was a significant association during the children's first two years between maternal smoking habits and rates of lower respiratory infection ($P < 0.01$) and a marginally significant ($P = 0.06$) association between maternal smoking habits and rates of lower respiratory symptoms. From the fitted model, estimates were obtained using the methods described by Lee²⁴ of the association between maternal smoking and rates of lower respiratory infection and symptoms that were adjusted for the effects of the control factors. The adjusted rates are shown in table 2 and indicate that the introduction of the control factors had a negligible effect on the general dose/response relationship between maternal smoking habits and rates of lower respiratory infection and symptoms in children under the age of 2 years.

Our initial analyses examined the data in a series of cross-sectional two-year blocks. To analyze the dynamic relationships that existed between maternal smoking and rates of lower respiratory illness and symptoms throughout the child's first 6 years, the data was used to form a 3×2 contingency table,²⁵ which described the associations between maternal smoking during the child's first 2 years and rates of lower respiratory infections and symptoms throughout the child's first 6 years. This table was fitted using log linear modeling methods. A summary of the analysis is shown in table 3, which gives values

Table 3—Fitted Log Linear Model of Maternal Smoking, Medical Consultations for Lower Respiratory Illness, and Maternal Reports of Lower Respiratory Symptoms, 0-6 yrs.

Factor	λ	σ^2	P
First order effects			
Maternal smoking: A			
Medical consultations 0-2 yrs: B			
Symptoms 0-2 yrs: C			
Medical consultations 2-4 yrs: D	682.68	0.1	$P < 0.0001$
Symptoms 2-4 yrs: E			
Medical consultations 4-6 yrs: F			
Symptoms 4-6 yrs: G			
Second order effects			
AB	15.42	0	$P < 0.01$
AC	7.96	0	$P < 0.05$
BC	176.75	1	$P < 0.0001$
BD	17.82	1	$P < 0.001$
CE	0.01	1	$P < 0.01$
DE	132.40	1	$P < 0.0001$
DF	96.28	1	$P < 0.0001$
EG	29.24	1	$P < 0.0001$
FG	132.97	1	$P < 0.0001$
Residual	131.73	177	$P > 0.99$

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of the log likelihood ratio chi-square statistics for the various effects in the fitted model. The results can be readily interpreted from figure 1, which shows the fitted model using the conventions described by Freeman and Jekel.¹² In this diagram, variables that were significantly related are shown linked by solid lines, and the size of the association is indicated by the log likelihood ratio chi-square value and its corresponding level of significance. Variables that were not significantly related are not linked by lines. The following conclusions can be drawn from the figure. 1) Maternal smoking was associated with significant increases in rates of lower respiratory illness ($P < 0.01$) and symptoms ($P < 0.05$) during the children's first 2 years. 2) Within each measuring period there were very strong associations ($P < 0.0001$) between medical consultations for lower respiratory illness and maternal reports of lower respiratory symptoms. These associations arose because if the child had attended a medical practitioner for lower respiratory illness, his or her mother almost invariably reported lower respiratory symptoms. 3) There were significant associations ($P < 0.001$) between rates of medical consultation for lower respiratory illness across measurement periods. Thus, lower respiratory infection during the first 2 years was significantly associated with lower respiratory infection during the period from 2 to 4 years, which in turn was associated with lower respiratory infection during the period from 4 to 6 years. A similar causal-chain model links the measures of maternal reports of lower respiratory symptoms.

As may be seen from Table 3, the model depicted in figure 1 produced a very satisfactory fit to the observed data ($\chi^2 = 131.73$; $df = 172$; $P = 0.99$).

Asthma During Early Childhood. Table 4 compares the number of children having at least one asthmatic episode (defined both on the basis of medical consultation and maternal report) by the age of 6 years with parental smoking habits. Inspection of the table shows no clear tendency for the proportions of asthmatic children to vary with parental smoking habits, and this was confirmed by log linear modeling of the results, which indicated that there was no significant association between being asthmatic and parental smoking habits.

Figure 1—Fitted log linear model of maternal smoking, medical consultation for lower respiratory illness, and maternal reports of lower respiratory symptoms in children 0-6 years of age.

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Table 4—Risks Per 100 Children of Having at Least One Asthmatic Episode by the Age of 6 Years by Parental Smoking Habits (Number of Children in Sample in Parentheses)

	Medical Consultation				Maternal Report			
	0	1-10	11+	Total	0	1-10	11+	Total
Paternal smoking (cigs/day):								
0	18.6 (460)	9.0 (67)	6.8 (74)	11.4 (601)	13.5 (460)	10.5 (67)	8.1 (74)	12.5 (601)
1-10	15.1 (86)	17.2 (64)	16.9 (65)	16.3 (215)	15.1 (86)	17.2 (64)	16.9 (65)	16.3 (215)
11+	17.2 (93)	19.3 (57)	9.1 (66)	13.4 (216)	17.2 (93)	14.0 (57)	10.6 (66)	14.4 (216)
Total	13.6 (639)	19.8 (188)	10.7 (205)	13.0 (1032)	14.2 (639)	13.8 (188)	11.7 (205)	13.7 (1032)

However, the results in table 4 do not take into account the possibility that, while parental smoking may not influence the child's predisposition to asthma, it may influence the frequency of asthmatic attacks among those susceptible to asthma. This issue is examined in table 5, which shows the frequency of asthmatic attacks per 100 children (measured both on the basis of maternal report and frequency of medical consultation) related to parental smoking habits. While there was substantial variability in the rates of asthmatic attacks depending on the combinations of parental smoking, there was no clear trend in the results that would suggest increased parental smoking was associated with increases in the rate of asthmatic attacks. This impression was confirmed by log linear modeling of the data in table 5, which showed there were no significant associations between parental smoking and the frequency of asthmatic attacks.

To examine the possible effects of various confounding factors on the associations between parental smoking and the occurrence of asthma in children and the rates of asthmatic attacks, the data were further analyzed using regression methods in which a number of control factors, including gender, family history of asthma, early eczema, early respiratory infection, breastfeeding history, pets in the family, family life events, and family social background were introduced as factors in stepwise analyses. The analysis of the risk data in table 4 was conducted using multiple logistic regression, whereas the frequency of attack data (table 5) were analyzed using multiple linear regression methods based on the square root of the number of episodes of asthma occurring during the period from 0-6 years. All analyses indicated that there were no significant relationships between parental smoking habits and risks of childhood asthma or rates of asthmatic attacks even when the set of control factors was taken into account statistically.

Discussion

The findings of this six-year longitudinal study indicate that the effects of parental smoking on childhood respiratory illness depended on the child's age, the source of parental smoke, and the outcome studied. There was clear evidence of a relationship during the child's first 2 years between maternal (but not paternal) smoking and both an increased rate of medical consultations for bronchitis/pneumonia and increased reports of lower respiratory symptoms. However, after this time, maternal smoking did not make a significant contribution to the rates of medical consultation or reports of lower respiratory symptoms. Paternal smoking was not related to lower respiratory illness at any time, and neither paternal nor maternal smoking was related to the risk of asthma or the frequency of asthmatic attacks during the child's first 6 years.

The finding of an association between lower respiratory illness or symptoms and parental smoking during the first two years of life confirms the findings of a number of previous studies^{1,2,10,11} and, as remarked earlier, the correlation appears to be resilient to the effects of statistical and other controls. Collectively, the available evidence strongly suggests that maternal smoking increases rates of lower respiratory illness and symptoms in children up to the age of 2 years. However, the mechanisms involved are as yet unclear. Colley et al.⁹ proposed a genetic explanation in which parental smoking is related to a genetic disposition to lower respiratory illness, which is reflected in higher rates of morbidity among the offspring of smokers. However, this explanation seems highly unlikely given that, according to most studies, maternal smoking is more important in this regard than is paternal smoking, which would suggest a mode of inheritance in which a predisposition to lower respiratory illness is sex linked to the child's mother.⁹ Fergusson et al.⁸ have suggested

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Table 5—Rate Per 100 Children Aged 0-6 Years of Asthmatic Attacks by Parental Smoking (Number of Children in Sample in Parentheses)

	Medical Consultation				Maternal Report			
	Parental Smoking (cigs/day)				Parental Smoking (cigs/day)			
	0	1-10	11+	Total	0	1-10	11+	Total
Paternal smoking (cigs/day)								
0	57.4 (460)	49.3 (67)	56.8 (74)	56.4 (601)	124.6 (460)	79.1 (67)	101.4 (74)	116.6 (601)
1-10	76.7 (86)	34.4 (64)	79.3 (65)	62.8 (215)	166.3 (86)	98.4 (64)	90.5 (65)	156.7 (215)
11+	95.7 (93)	38.6 (57)	56.1 (66)	68.5 (216)	163.4 (93)	59.7 (57)	130.2 (66)	125.9 (216)
Total	65.6 (639)	41.0 (188)	61.5 (205)	60.3 (1032)	135.8 (639)	79.8 (188)	142.4 (205)	126.9 (1032)

a hypothesis in which prolonged exposure to cigarette smoke has an irritant effect that exacerbates the respiratory infections that normally occur during early childhood, making it more likely that lower respiratory symptoms will develop.

However, whereas previous studies^{11,12} have reported associations between lower respiratory symptoms, lower respiratory illness or impaired pulmonary function, and parental smoking for school-aged children, we were unable to find any association between parental smoking and respiratory illness or symptoms during the period from 2-6 years. It seems possible that this may reflect the age of the children studied. In particular, it seems likely that prolonged exposure to parental smoke may have an accumulative effect¹³ on pulmonary function and susceptibility to lower respiratory illness, and it is possible that our sample of children was too young for any increase in rates of morbidity or symptoms to be detected. In contrast, the previous studies that have demonstrated associations in school-aged children have examined older populations or populations with a wider age range than our sample.

It has been suggested that the association between parental smoking and lower respiratory symptoms and illness in school-aged children may reflect the indirect consequences of early exposure to cigarette smoke. Tager et al.¹⁴ argue that such early exposure coupled with increased risks of early lower respiratory illness may cause structural changes that are reflected in increased rates of lower respiratory symptoms and reduced pulmonary function during later childhood. The results of the longitudinal log-linear analysis presented in this paper cast some light on the plausibility of this hypothesis. In particular, the model suggested that maternal smoking was associated with an increased risk of lower respiratory illness and symptoms during the child's first 2 years, and that early respira-

tory illness or symptoms during the first 2 years are associated with subsequent illness or symptoms. At first sight these results would appear to support the hypothesis that early exposure to parental smoke leads to later respiratory illness. However, this view does not take into account the statistical "slippage" that occurs within this system of relationships. Thus, while maternal smoking does influence early respiratory illness, and early respiratory illness is related to later respiratory illness, maternal smoking made a negligible direct or indirect contribution to later respiratory illness for our cohort. This suggests that the tendency for rates of lower respiratory illness or symptoms to be correlated over time cannot be attributed to the common effects of maternal smoking on respiratory function.

A more plausible explanation of the existing data would appear to be that there are two mechanisms involved in the correlations between parental smoking and lower respiratory illness and symptoms in children. First, during early childhood there is a short-term effect by which exposure to cigarette smoke has the effect of increasing the likelihood of early respiratory illness. This effect is relatively short lived and disappears at around the age of 2 years. However, in the light of the findings of Tager et al.¹⁴ there is also evidence to suggest that prolonged exposure to parental smoking may have the effect of gradually compromising the lower respiratory system of children so that around the middle-school years, children become at greater risk of lower respiratory illness and reduced pulmonary function.

In confirmation of three previous studies,^{11,12,15} we were unable to show any correlation between parental smoking and either the onset or frequency of asthmatic attacks during early childhood. These results suggest that, while parental smoking may predispose children to develop lower respiratory illness and symptoms, it is not implicated in the development of asthma or the

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frequency of asthmatic attacks in young children. At the same time, Gortmaker et al.²² were able to show a small but nonetheless significant association between parental smoking habits and asthma in a cross-sectional sample of children aged from 0–17 years. It seems possible that these differences may reflect age differences between samples. If, as was conjectured previously, prolonged exposure to cigarette smoke has a subtle, long-term effect on respiratory function, it is possible that an association between parental smoking and childhood asthma exists only in older children who have experienced sufficient exposure to parental smoke to increase their susceptibility to asthmatic attacks. It should also be noted that the apparent correlation between parental smoking and asthma reported by Gortmaker et al.²² could be a disguised correlation between asthma and smoking in the child,^{20,21} as this factor was not controlled for in their analyses.

Finally, while the results of this study support the general conclusion that parental smoking may be harmful to children, the results suggest the possibility of complex relationships between the child's age, duration of exposure to smoke, and various measures of respiratory illness and function. Such relationships can only be clarified by further longitudinal studies that examine the way in which varying exposure times to parental smoking have dynamic effects on both the susceptibility to lower respiratory illness and pulmonary function throughout childhood.

This research was funded by grants from the Medical Research Council of New Zealand and the National Children's Health Research Foundation.

References

1. Colley JT, Morland WW, Corhill RT. Influence of passive smoking and parental phlegm on pneumonia and bronchitis in early childhood. *Lancet* 1974; ii:1031–1034.
2. Mariad S, Davies AM. Infant admissions to hospital and maternal smoking. *Lancet* 1974; i:589–539.
3. Leeder SR, Corhill RT, Irving LM, et al. Influence of family factors on the incidence of lower respiratory illness during the first year of life. *Br J Soc Prev Med* 1976; 30:903–919.
4. Fergusson DM, Horwood LJ, Shannon FT. Parental smoking and respiratory illness in infancy. *Arch Dis Child* 1980; 55:358–361.
5. Fergusson DM, Horwood LJ, Taylor B. Parental smoking and lower respiratory illness in the first three years of life. *J Epidemiol Community Health* 1981; 35:181–184.
6. Cameron R, Rosin JS, Zeks JM, et al. The health of smokers and non-smokers children. *J Allergy* 1969; 43:336–341.
7. Colley JT. Respiratory symptoms in children and parental smoking and phlegm production. *Br Med J* 1974; ii:901–904.
8. Norman Taylor W, Dickinson VA. Dangers for children in smoking families. *Community Med* 1979; 198:39–33.
9. Bland M, Bewley BR, Pollard V, et al. Effect of children's and parents' smoking on respiratory symptoms. *Arch Dis Child* 1978; 53:100–105.
10. Schenker MB, Samet JM, Soetzer FE. Risk factors for childhood respiratory disease. *Am Rev Respir Dis* 1983; 128:1038–1043.
11. Weiss ST, Tager IB, Soetzer FE, et al. Persistent wheeze: its relation to respiratory illness, cigarette smoking and level of pulmonary function in a population sample of children. *Am Rev Respir Dis* 1980; 122:697–707.
12. Ware JM, Dockery DW, Spoto A, et al. Passive smoking, gas cooking, and respiratory health of children living in six cities. *Am Rev Respir Dis* 1984; 129:366–374.
13. Charlton A. Children's coughs related to parental smoking. *Br Med J* 1984; 288:1647–1649.
14. Hesselblad V, Humber CG, Graham AG, et al. Indoor environmental determinants of lung function in children. *Am Rev Respir Dis* 1981; 123:479–485.
15. Tager IB, Weiss ST, Rosner B, et al. Effect of parental cigarette smoking on the pulmonary function of children. *Am J Epidemiol* 1979; 110:15–26.
16. Tager IB, Weiss ST, Munoz A, et al. Longitudinal study of the effects of maternal smoking on pulmonary function in children. *New Eng J Med* 1983; 309:699–703.
17. Schilling RSF, Letai AD, Muir SL, et al. Lung function, respiratory disease, and smoking in families. *Am J Epidemiol* 1977; 106:974–983.
18. Dooge RP. The effects of indoor air pollution on Arizona children. *Am Rev Respir Dis* 1982; 125:146 (abstract).
19. Leeder SR, Corhill RT, Irving LM, et al. Influence of family factors on asthma and wheezing during the first five years of life. *Br J Soc Prev Med* 1976; 30:913–918.
20. Horwood LJ, Fergusson DM, Shannon FT. Social and familial factors in the development of early childhood asthma. *Pediatrics* (in press).
21. O'Connell EJ, Logan GB. Parental smoking in childhood asthma. *Ann Allergy* 1974; 32:142–145.
22. Gortmaker SL, Walker DC, Jacobs FM, et al. Parental smoking and the risk of childhood asthma. *Am J Public Health* 1982; 72:574–579.
23. Williams H, McNeill RN. Prevalence, natural history and relationship of wheezy bronchitis and asthma in children. An epidemiological study. *Br Med J* 1969; 4:321–325.
24. Eley WB, Irving JC. Revised scale of socioeconomic status for New Zealand. *NZ J Educ Stud* 1976; 1:25–36.
25. Holmes TM, Rahe RM. The Social Readjustment Rating Scale. *J Psychosom Res* 1967; 11:913–918.
26. Brown MB. BMD: Two-way and multi-way frequency tables—measures of association and the log linear model: complete and incomplete tables. In: Dixon WJ, et al (eds). *BMDP Statistical Software* 1981. Berkeley: University of California Press, 1981.
27. Engelman L. PLR Stepwise Logistic Regression. In: Dixon WJ, et al (eds). *BMDP Statistical Software* 1981. Berkeley: University of California Press, 1981.
28. Lee J. Covariance adjustment of rates based on the multiple logistic regression model. *J Chron Dis* 1981; 34:415–426.
29. Freeman DM, Jekel JF. Table selection and log linear models. *J Chron Dis* 1980; 33:513–524.
30. Bewley BR, Bland JM, Harris R. Factors associated with starting cigarette smoking by primary school children. *Br J Soc Prev Med* 1974; 28:37–44.
31. Bonas MM, Bewley BR, Bland JM, et al. Long term study of smoking by secondary school children. *Br J Soc Prev Med* 1977; 31:18–24.

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